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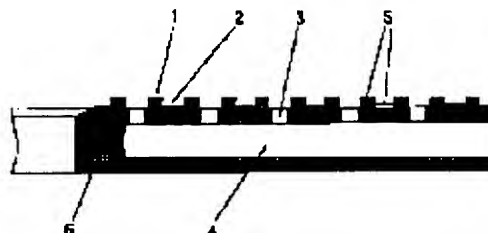
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(54) SEMICONDUCTOR WAFER VACUUM CHUCK MADE OF SINTERED SILICON CARBIDE SUBSTRATE COATED WITH CHEMICALLY VAPORIZED SILICON CARBIDE

(57)Abstract:

PROBLEM TO BE SOLVED: To provide good anti-abrasive characteristics and reduce contamination stuck to a vacuum chuck, by preventing static electricity at a contacted position with a workpiece.

SOLUTION: A position (of a vacuum chuck holder) contacted with a workpiece in a semiconductor wafer carrying and holding apparatus is made of ceramics composite, namely a silicon carbide substrate 6 that is coated with a film of the same kind of silicon carbide in a reduced pressure chemical evaporation method under non-oxidizing atmosphere. A composite material structure for the vacuum chuck holder includes a base substrate of  $\alpha$ -type or  $\beta$ -type sintered silicon carbide, and the formed film is made of  $\beta$ -type crystallized silicon carbide.



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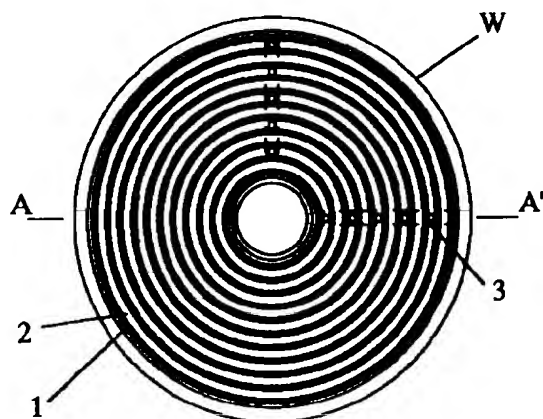
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(54) 【発明の名称】 焼結炭化硅素基体上に化学蒸着炭化硅素膜をコーティングした半導体ウエハ用真空チャック

(57) 【要約】

【解決手段】半導体ウエハ搬送・保持装置の被保持物との接触部分(真空チャックホルダ)が、焼結炭化硅素基体上に化学蒸着炭化硅素膜をコーティングしてなることを特徴とする真空チャックホルダ。

【効果】 耐摩耗性が向上すると共に、被保持物との接触部分における静電気の発生が防止され、ごみの付着が低減される。



## 【特許請求の範囲】

【請求項1】 半導体ウエハ搬送・保持装置の被保持物との接触部分（真空チャックホルダ）が、焼結炭化硅素基体上に化学蒸着炭化硅素膜をコーティングしてなることを特徴とする真空チャックホルダ。

【請求項2】 前記請求項1記載の焼結炭化硅素基体が導電性を有する $\alpha$ 型炭化硅素、または $\beta$ 型炭化硅素よりなり、化学蒸着炭化硅素膜が $\beta$ 型炭化硅素であることを特徴とする真空チャックホルダ。

【請求項3】 前記請求項1記載の化学蒸着炭化硅素膜が、ミラー指数表示（111）、（110）、（220）および（200）結晶面配向を有する蒸着膜よりなることを特徴とする真空チャックホルダ。

【請求項4】 前記請求項1記載の化学蒸着炭化硅素膜が、前記請求項3記載の4種の結晶面配向中の任意の2種、または、3種の結晶面配向構成成分を含有する蒸着膜よりなることを特徴とする真空チャックホルダ。

【請求項5】 前記請求項1記載の化学蒸着炭化硅素膜が、ミラー指数表示（220）面配向結晶構成成分とその他の面配向結晶構成成分の比において、X線回折強度で50倍以上よりなることを特徴とする真空チャックホルダ。

【請求項6】 前記請求項1記載の化学蒸着炭化硅素膜が、非酸化性雰囲気のもとに減圧化学蒸着法によって成膜されることを特徴とする真空チャックホルダ。

## 【発明の詳細な説明】

## 【0001】

【発明の属する技術分野】本発明は、例えば半導体基板（ウエハ）やアルミナ、石英等の薄板状基板を吸着固定に好適に用いられる真空チャックに関するものである。

## 【0002】

【従来の技術】半導体集積回路の製造工程においては、ウエハを搬送したり、所定位置に固定したりするための種々の保持装置が用いられている。例えば、リソグラフィ工程の中心的役割を担う露光装置では、薄板状のウエハを平面内に固定するために真空チャックの装置が使用されている。

【0003】従来、この種の真空チャック本体に使用される材料はアルミニウム合金にアルマイト処理を施したものや、アルミナセラミックスが用いられていた。アルミニウム合金製の真空チャックホルダにおいては、摩擦等により吸着面の精度を長期間にわたって維持できない問題がある。一方、アルミナセラミックス製の真空チャックホルダにおいては、使用時にチャックホルダが帯電して塵埃が付着し、ウエハの吸着精度が低下する問題がある。

【0004】又、半導体集積回路の微細化に伴い、ウエハ露光面は完全2次元平面、および、超平滑面である必要がある。それに従い、ウエハを支持する真空チャックホルダの吸着面の面精度は超平滑面が必要となった。機

械加工により形成する真空チャックホルダの面加工において、アルミニウム合金は軟らかく加工が容易であるが、反面、容易に劣化する。アルミナセラミックスよりなる真空チャックホルダの面研磨は硬く容易でない。

## 【0005】

【発明が解決しようとする課題】前記従来技術に述べたように、真空チャックホルダ材料が求められる特性は

（1）耐摩耗性に優れていること、すなわち、硬度が大きいこと。

（2）気孔があったり、帯電したりしてゴミを吸着しないこと。

（3）熱膨張係数が小さいこと。

（4）比重が小さく、高強度であること。

（5）被加工性に優れていること。

である。上記特性をより詳しくみると次のようになる。

【0006】ウエハと真空チャックホルダは接触している。真空チャックホルダは繰り返しウエハを積載し、搬送する。したがって、表面は摩耗し、損傷する。ウエハが真空チャックホルダに吸着された状態で期待される状態は、第一に吸着によってウエハの表面が露光装置の光の作る最適位置、すなわち、出来るだけ完全な二次元平面に矯正されることである。したがって、ホルダの摩耗に起因する保持面の欠陥によるウエハの変形を防止するため、および、ウエハとの接触によるアブレッシブ摩耗により発生する微粒子のウエハとホルダ間介在による平面の変形を防止するためには、真空チャックホルダとウエハの接触部の耐摩耗性、および、硬度が高いことが望まれる。また、微粒子が表面に付着すると、回路転写時に断線・短絡が生じる。

【0007】前述のアブレッシブ摩耗の外に、ゴミが、帯電した真空チャックホルダへの吸着すること、セラミックス表面気孔への侵入すること、等が前記障害と同様な障害を生ずる。

【0008】露光装置の真空チャックホルダにおいて、露光によって熱が蓄積される。このため、ホルダの熱膨張係数が大きいと、ホルダに吸着固定されているウエハの寸法変化を拡大させることになる。従って、回路転写時の寸法誤差を抑制するためには、熱膨張係数ができるだけ小さいことが望まれる。

【0009】半導体回路用ウエハのサイズは、ダイ歩留向上のために段々大型化してきた。それに伴い、搬送装置、直接には真空チャックホルダの負荷が大きくなってきた。すなわち、真空チャックホルダ材料の機械的強度が強い材料が必要になってきた。材料厚みを増し、強度を強くすることは、装置の軽量化に反する。

【0010】材料の機械加工で最も時間・労力を費やす工程は研磨工程である。しかして、真空チャックホルダとウエハが接触する面は真空吸着による平坦度矯正のため超平滑面である必要がある。したがって、真空チャックホルダ材料の研磨被加工性が重要な特性となる。

【0011】近年、上記必要特性を満たす材料としてセラミックス材料が開発されている。従来のセラミックス材料は一般に極めて硬いものであることから、前記した如き超平滑面に表面研磨するには多大な労力、および、研磨エネルギーを必要とする。強研磨加工を行うために、かえって研磨面が損傷し易く、高精度の平滑面を得ることが困難であった。

#### 【0012】

【課題を解決するための手段】本発明では、前記課題を解決するために、真空チャックホルダは、焼結炭化硅素基体上に、非酸化性雰囲気下で減圧化学蒸着によって同種炭化硅素膜を形成した、セラミックス複合体で構成する。本発明において、真空チャックホルダに用いられる好ましい複合体材料構成としては、基体に $\alpha$ 型、または、 $\beta$ 型焼結炭化硅素を用い、成膜された膜は、結晶化した $\beta$ 型構造の炭化硅素が挙げられる。

【0013】また、本発明においては炭化硅素焼結体を直接ウエハとの接触部に用いるのではなく、化学蒸着炭化硅素膜を表面に用い、研磨加工を容易にする膜構造を選択するために、製造が容易である。

【0014】また、本発明に用いる焼結炭化硅素複合体は導電性を有する。すなわち、本発明の真空チャックホルダでは、セラミックス焼結体の持つ、高剛性 軽量、\*

\*高硬度という特性に、導電性という特性が付加される。したがって、耐摩耗性が向上すると共に、被保持物との接触部分における静電気の発生が防止され、ごみの付着が低減される。

【0015】従来の炭化硅素材料における表面研磨の困難性が炭化硅素表面の結晶面が無配向となっていることに起因することを改良し、本発明では、炭化硅素蒸着膜の結晶面を配向させ、劈開面を揃えることによって、より少ない研磨エネルギーで、損傷の発生を極力防ぎながら超平滑面に表面研磨できる。

【0016】更に、本発明における化学蒸着膜は緻密であり、通常のセラミックス表面のように気孔を有していない。従って、本発明の真空チャックホルダと被保持物との接触部では、気孔への異物の付着がなく、かつ、付着したとしても清掃除去が容易である。

【0017】ここで、従来の真空チャックホルダに使用されていた各材料と本発明の化学蒸着炭化硅素複合体の物性を表1に示す。比較材料として金属、セラミックス、それぞれの代表であるステンレス鋼、アルミナの各物性値を示す。

#### 【0018】

【表1】

	弾性率 (Kg/mm <sup>2</sup> )	比重	表面 気孔状態	電気抵抗 ( $\Omega \cdot \text{cm}$ )	硬度 (Hv)	熱膨張係数 ( $\times 10^{-6}/^{\circ}\text{C}$ )
ステンレス鋼	20,000	8.1	中	$7 \times 10^{-4}$	200	17.3
Al <sub>2</sub> O <sub>3</sub>	35,000	3.8	悪	$\geq 10^4$	1,800	7.1
焼結SiC + 蒸着SiC膜 (本発明)	40,000	3.1	良	$10^9$	2,500	4.1

【0019】平坦度を要求されるホルダや、小型・高性能を要求される搬送装置用材料への適用評価特性値として、弾性率と比重を比較すると、両者共に本発明による化学蒸着炭化硅素複合体が、弾性率は大きく、比重は小さいという最も望ましい値を示している。

【0020】また、熱膨張係数も三者中で最も小さく、長時間露光によって蓄熱されるような場合でも寸法変化は少ない。即ち、ホルダに吸着固定されているウエハ回路転写時の寸法誤差を低く抑えることができる。

#### 【0021】

【作用】本発明の非酸化性雰囲気下の減圧化学蒸着炭化硅素複合体が、前述の諸課題を解決する手段を提供していることを示した。この手段の中で、一般に言われているセラミックスの加工困難性を解決する上において、本発明の蒸着膜は重要な作用、効果をもたらす。

【0022】セラミックス材の加工困難性を克服するために、放電加工法が採用されている。放電加工される領※50

※域は、ウエハを吸着する溝、および、真空吸引孔であり、ウエハと接触する重要な面は研磨加工に頼らざるを得ない。セラミックス材料の最も機械加工困難な段階は研磨加工である。

【0023】本発明になる化学蒸着炭化硅素膜は蒸着条件によって多種の膜構造を創成する。しかも、膜構造によって研磨加工の労力が大きく異なる作用をなす。例えば、真空チャックホルダを形成する基体の表面に高純度の $\beta$ 型炭化硅素を化学蒸着して、結晶面をミラー指数表示(220)面、及び、(111)面に配向するように調製して得られる蒸着膜がある。この蒸着膜と無配向の蒸着膜を、研磨加工における研磨エネルギー、時間で比較すると、配向した蒸着膜の方が遥かに消費エネルギーは少なかった。かつ、研磨面の状態も明瞭な差がみられ、配向膜の方が優れていた。すなわち、本発明になる真空チャックホルダ用化学蒸着炭化硅素複合体セラミックスは、現在ウエハ保持材として使用されているセラミ

ックスと同等の特性を持ちながら、最も重要なウエハとの接触面の超平滑面の加工に優れた作用をしている。

#### 【0024】

【実施例】以下、図面を参照して本発明の実施例について説明する。図1は本発明の真空チャックホルダの概略的な構造を示す平面図、図2は図1のA、A'断面図である。図3は図2の一部分の拡大図である。ホルダWHのウエハ吸着面の形状はウエハWの直径よりわずかに小さい径の円形であり、ウエハ吸着面にはホルダWHの中心から同心円状の複数の環状凸部（ウエハW支持部）1と環状凹部（真空吸着溝）2とが一定のピッチでリム状に形成されている。

【0025】また、各環状凹部2には真空吸着のための吸気孔3が半径方向に並べて形成され、各吸気孔3は、ホルダWH内部に半径方向に伸びたスリーブ状の孔4と連通している。この孔4を真空源につなげて減圧することによって、ウエハWの裏面と各環状凹部2で囲まれる空間が負圧になり、ウエハWの裏面は複数の環状凸部1の上面にならって、平坦化矯正される。

【0026】本実施例では、ホルダWH本体は、焼結炭化硅素基体上に非酸化性雰囲気減圧化学蒸着で成膜した炭化硅素膜でコーティングして構成した。まず、図1、および、図2の形状をなす $\alpha$ 型炭化硅素基体を焼結した。焼結型枠には、環状凹凸部1、および、2（深さ0.2~0.5mm）が予め加工されているので、成型された焼結ホルダ基体には、転写された凹凸がある。改めて、正確な環状凸部1の山幅が0.2mmになるように機械加工を行い、表面が面粗さ0.01mmまで研磨加工を行った。

【0027】この基体のウエハ保持面、および、真空吸引溝面を同時に膜加工する。すなわち、環状凸部1、および、環状凹部2表面に高純度炭化硅素の化学蒸着を2つの異なった蒸着条件下で行った。一つは蒸着温度1300℃、蒸着速度10~数10 $\mu$ m/h、非酸化性雰囲気下の減圧蒸着であり、他は同一蒸着温度、同一蒸着速度で、非酸化性雰囲気下の常圧蒸着である。得られた二つの真空チャックホルダ表面を、ダイヤモンドパウダーにて5時間機械研磨を行った。上記減圧雰囲気下で蒸着した膜表面は、研磨によって8 $\text{\AA}$  rmsに仕上がり、常圧雰囲気下で成膜した膜表面は500 $\text{\AA}$  rmsであった。両蒸着膜の結晶構造をX線回折にて比較すると、減圧雰囲気下で成膜した膜の結晶構造はミラー指数表示（220）面が（111）の面に比較して約5.2倍であり、常圧雰囲気下でのものは約3.2倍であった。上記実施例では、被研磨加工性が（220）方向への配向が多

い蒸着面ほど優れていることを示している。なを、結晶構造において、配向した材料と無配向の材料では、配向をなくすほど研磨が困難になることは判明している。

【0028】また蒸着面、すなわち、ウエハ吸着面には気孔は殆ど無い。したがって、吸着面にゴミが付着することは少なく、ウエハWとの間にゴミが介在することによってウエハWの平坦度が低下することが起こりにくい。また、高硬度であるので、アブレッシブ摩耗によって微粒子が発生してウエハWに付着するということもない。 $\alpha$ 型炭化硅素焼結体は導電性であるので静電気の発生による真空チャックホルダへのゴミの付着は生じない。仮にゴミが付着したとしても容易に除去することができ、真空チャックホルダの清掃が簡単である。更に、本実施例の真空チャックホルダは、熱膨張係数が小さいので、露光時の蓄熱による寸法変化が少ない。従って、高感度のフォトレジストを用いて、低強度の光で長時間露光する場合にも、ウエハの寸法誤差を許容範囲内に抑えることができる。

#### 【0029】

【発明の効果】以上の様に本発明においては、真空チャックホルダが導電性炭化硅素焼結体上を、非酸化性雰囲気下で減圧化学蒸着炭化硅素膜でコーティングしてなり、その生成膜が結晶構造を形成することによって、セラミックス材料で最も困難な研磨加工を容易にする効果を示す。また、結晶化膜には気孔がなく、かつ、導電性のために静電気の発生によるゴミの付着が防止されて、保持装置の清掃も簡単である。またセラミックス特有の高剛性、軽量である特性のもたらす真空チャックホルダ構造の強靱性は、ウエハ吸着による被保持物の平坦化矯正を行うことを長時間にわたり安定して可能にする。更に、小さい熱膨張率をもたらす高寸法安定性の特性を有するので、蓄熱による寸法変化が問題となる場合にも有利である。

#### 【図面の簡単な説明】

【図1】真空チャックの平面概略図。

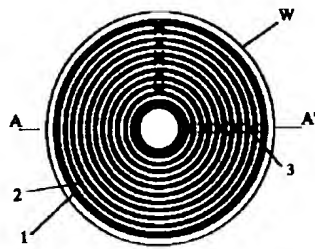
【図2】真空チャックの断面概略図。

【図3】真空チャック断面概略図の一部分拡大図。

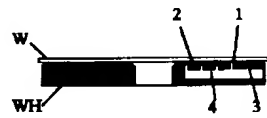
#### 【符号の説明】

- 1 環状凸部（ウエハ支持部）
- 2 環状凹部（真空吸着溝）
- 3 吸気孔
- 4 真空吸引孔
- 5 蒸着炭化硅素膜（凸部はウエハと接触部）
- 6 焼結炭化硅素基体

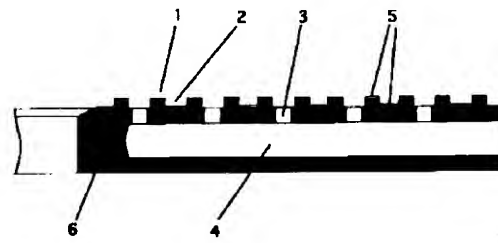
【図1】



【図2】



【図3】



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DETAILED DESCRIPTION

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## [Detailed Description of the Invention]

[0001]

[The technical field to which invention belongs] this invention relates sheet metal-like substrates, such as for example, a semiconductor substrate (wafer), and an alumina, a quartz, to the vacuum chuck used suitable for adsorption fixation.

[0002]

[Description of the Prior Art] In the manufacturing process of a semiconductor integrated circuit, the various supporting structure for conveying a wafer or fixing to a predetermined position is used. For example, in the aligner which bears the role rate of central of a lithography process, since a sheet metal-like wafer is fixed in a flat surface, the equipment of a vacuum chuck is used.

[0003] Conventionally, that by which the material used for this kind of vacuum-chuck main part performed alumite processing to the aluminium alloy, and alumina ceramics were used. In the vacuum-chuck electrode holder made from an aluminium alloy, there is a problem which cannot maintain precision of an adsorption side over a long period of time by wear etc. On the other hand, in the vacuum-chuck electrode holder made from alumina ceramics, at the time of use, a chuck electrode holder is charged, dust adheres and there is a problem to which the adsorption precision of a wafer falls.

[0004] moreover, detailed-izing of a semiconductor integrated circuit -- following -- a wafer exposure side -- a perfect two-dimensional flat surface -- and it is necessary overly to be a smooth side According to it, as for the profile irregularity of the adsorption side of the vacuum-chuck electrode holder which supports a wafer, a smooth side is overly needed. In field processing of the vacuum-chuck electrode holder formed with machining, although an ARUMYUUMU alloy is softly easy to process it, on the other hand, it deteriorates easily. Field polish of the vacuum-chuck electrode holder which consists of alumina ceramics is not firmly easy.

[0005]

[Problem(s) to be Solved by the Invention] Property that vacuum-chuck electrode-holder material is called for as stated to the aforementioned conventional technology (1) Excelling in abrasion resistance, a \*\*\*\* bee, and a degree of hardness are large.

(2) Be, or pore should be charged and don't adsorb dust.

(3) A coefficient of thermal expansion is small.

(4) Specific gravity is small and it is high intensity.

(5) Excel in workability.

It comes out. It is as follows when the above-mentioned property is seen in more detail.

[0006] The wafer and the vacuum-chuck electrode holder touch. A vacuum-chuck electrode holder loads and conveys a repeat wafer. Therefore, a front face is worn out and damaged. The state where a wafer is expected where a vacuum-chuck electrode holder is adsorbed is that the front face of a wafer is corrected by adsorption in the first place at the optimal position which the light of an aligner makes, a \*\*\*\* bee, and the most perfect possible 2-dimensional flat surface. Therefore, in order to prevent deformation of the wafer by the defect of the maintenance side resulting from wear of a electrode holder,

and in order to prevent the wafer of a particle generated by abb RESSHIBU wear by contact to a wafer, and deformation of the flat surface by the intervention between electrode holders, it is desired for the abrasion resistance of the contact section of a vacuum-chuck electrode holder and a wafer and a degree of hardness to be high. Moreover, if a particle adheres to a front face, an open circuit and a short circuit will arise at the time of a circuit imprint.

[0007] The thing to the vacuum-chuck electrode holder with which the contaminant was charged besides the above-mentioned abb RESSHIBU wear to adsorb, the thing to ceramic surface pore to invade produce the aforementioned obstacle and the same obstacle.

[0008] Heat is accumulated by exposure in the vacuum-chuck electrode holder of an aligner. For this reason, when the coefficient of thermal expansion of a electrode holder is large, the dimensional change of the wafer by which adsorption fixation is carried out is made expanded to a electrode holder. Therefore, in order to suppress the size error at the time of a circuit imprint, it is desired for a coefficient of thermal expansion to be small as much as possible.

[0009] The size of the wafer for semiconductor circuits has carried out steps enlargement for the improvement in the die yield. A transport device and directly in connection with it, the load of a vacuum-chuck electrode holder is becoming large. Material with the strong mechanical strength of a \*\*\*\* bee and vacuum-chuck electrode-holder material has been needed. It is contrary to lightweight-ization of equipment to strengthen increase of material thickness and intensity.

[0010] The process which spends time and an effort most with machining of material is a polish process. It is necessary to carry out a deer and there overly needs to be a field where a vacuum-chuck electrode holder and a wafer contact in respect of smooth for the flatness reform by vacuum adsorption. It follows. The polish workability of vacuum-chuck electrode-holder material turns into an important property.

[0011] In recent years, ceramic material is developed as a material which fulfills the above-mentioned required property. Generally from it being a stiff thing very much, the conventional ceramic material needs an effort great for carrying out surface polish, and polish energy for said \*\*\*\* super-common glide plane. In order to perform strong polish processing, it was difficult on the contrary to be easy to damage a polished surface, and to acquire a highly precise smooth side.

[0012]

[Means for Solving the Problem] By this invention, in order to solve the aforementioned technical problem, a vacuum-chuck electrode holder consists of ceramic complex which formed the of-the-same-kind carbonization silicon film by the reduced pressure chemical vacuum deposition under the non-oxidizing atmosphere on the sintering carbonization silicon base. In this invention, as desirable complex material composition used for a vacuum-chuck electrode holder, alpha type or beta type sintering carbonization silicon is used for a base, and the carbonization silicon of beta type structure which crystallized the formed film is mentioned.

[0013] Moreover, manufacture is easy in order to choose the membrane structure which does not use a carbonization silicon sintered compact for the contact section with a direct wafer in this invention, but uses a chemical-vacuum-deposition carbonization silicon film for a front face, and makes polish processing easy.

[0014] Moreover, the sintering carbonization silicon complex used for this invention has conductivity. High rigidity which a ceramic sintered compact has in a \*\*\*\* bee and the vacuum-chuck electrode holder of this invention The property of conductivity is added to the property of lightweight and a high degree of hardness. Therefore, while abrasion resistance improves, generating of static electricity in a contact portion with a held object is prevented, and adhesion of a contaminant is reduced.

[0015] While the crystal face of a carbonization silicon front face prevents generating of an injury as much as possible with fewer polish energy by improving originating in it being non-orientation, carrying out orientation of the crystal face of a carbonization silicon vacuum evaporatio film, and arranging a cleavage plane in this invention, the surface polish of the difficulty of the surface polish in the conventional carbonization silicon material can overly be carried out in a smooth side.

[0016] Furthermore, the chemical-vacuum-deposition film in this invention is precise, and does not have pore like the usual ceramic front face. Therefore, in the contact section of the vacuum-chuck electrode

holder of this invention, and a held object, there is no adhesion of the foreign matter to pore, and though adhered, cleaning removal is easy.

[0017] The physical properties of the chemical-vacuum-deposition carbonization silicon complex of each material currently used for the conventional vacuum-chuck electrode holder here and this invention are shown in Table 1. Each physical-properties value of stainless steel and an alumina which is a metal, ceramics, and each representation is shown as a comparison material.

[0018]

[Table 1]

	弾性率 (Kg/mm <sup>2</sup> )	比重	表面 気孔状態	電気抵抗 ( $\Omega \cdot \text{cm}$ )	硬度 (Hv)	熱膨張係数 ( $\times 10^{-5}/^{\circ}\text{C}$ )
ステンレス鋼	20,000	8.1	中	$7 \times 10^{-5}$	200	17.3
Al <sub>2</sub> O <sub>3</sub>	35,000	3.8	悪	$\geq 10^{14}$	1,800	7.1
焼結SiC + 蒸着SiC膜 (本発明)	40,000	3.1	良	$10^{10}$	2,500	4.1

[0019] As application evaluation weighted solidity to the electrode holder of which flatness is required, and the charge of transport-device material of which small and high performance are required, if the chemical-vacuum-deposition carbonization silicon complex of an elastic modulus according to this invention in both if an elastic modulus is compared with specific gravity is large and specific gravity is small, the value also with desirable \*\*\*\*\* is shown.

[0020] Moreover, a coefficient of thermal expansion is also the smallest in 3 persons, and even when accumulation is carried out by prolonged exposure, there are few dimensional changes. That is, the size error at the time of the wafer circuit imprint by which adsorption fixation is carried out can be low suppressed to a electrode holder.

[0021]

[Function] Offering a means by which the reduced pressure chemical-vacuum-deposition carbonization silicon complex under the non-oxidizing atmosphere of this invention solves many above-mentioned technical problems was shown. In this means, the processing difficulty of the ceramics generally said is solved upwards, and the vacuum evaporatio film of this invention brings about an important operation and an effect.

[0022] In order to conquer the processing difficulty of ceramic material, electric spark forming is adopted. the slot where the field by which an electron discharge method is carried out adsorbs a wafer, and vacuum suction -- it is a hole and cannot but depend for the important field in contact with a wafer on polish processing The stage with the most difficult machining of ceramic material is polish processing.

[0023] The chemical-vacuum-deposition carbonization silicon film which becomes this invention generates various membrane structures according to vacuum evaporatio conditions. And the effort of polish processing makes a greatly different operation by the membrane structure. For example, there is a vacuum evaporatio film prepared and obtained so that the chemical vacuum deposition of the beta type carbonization silicon of a high grade may be carried out to the front face of the base which forms a vacuum-chuck electrode holder and orientation of the crystal face may be carried out to a Miller-indices display (220) side and a field (111). When this vacuum evaporatio film was compared with the vacuum evaporatio film of non-orientation in the polish energy in polish processing, and time, consumption energy had far few vacuum evaporatio films which carried out orientation. And the clear difference was seen and the state of a polished surface was also excellent in the direction of an orientation film. The chemical-vacuum-deposition carbonization silicon complex ceramics for vacuum-chuck electrode holders which become a \*\*\*\* bee and this invention are carrying out the operation of

the contact surface with the most important wafer which was overly excellent in processing of a smooth side, having a property equivalent to the ceramics currently used as present wafer maintenance material. [0024]

[Example] Hereafter, the example of this invention is explained with reference to a drawing. The plan in which drawing 1 shows the rough structure of the vacuum-chuck electrode holder of this invention, and drawing 2 are the A.A' cross sections of drawing 1. Drawing 3 is some enlarged views of drawing 2. The slightly small path of the configuration of the wafer adsorption side of a electrode holder WH is more nearly circular than the diameter of Wafer W, and two or more concentric circle-like annular heights (wafer W supporter) 1 and annular crevices (vacuum adsorption slot) 2 are formed in the wafer adsorption side in the shape of a rim in the fixed pitch from the center of a electrode holder WH.

[0025] moreover, the inhalation of air for the vacuum adsorption in each annular crevice 2 -- a hole 3 arranges and forms in radial -- having -- each inhalation of air -- the hole 3 is open for free passage with the hole 4 of the shape of a sleeve extended to radial inside electrode-holder WH By tying this hole 4 to the source of a vacuum, and decompressing it, the space surrounded in the rear face and each annular crevice 2 of Wafer W becomes negative pressure, the rear face of Wafer W is learned from the upper surface of two or more annular heights 1, and flattening reform is carried out.

[0026] The carbonization silicon film which formed membranes by the non-oxidizing-atmosphere reduced pressure chemical vacuum deposition coated and constituted the electrode-holder WH main part from this example on the sintering carbonization silicon base. First, drawing 1 and alpha type carbonization silicon base which makes the configuration of drawing 2 were sintered. Since the annular irregularity sections 1 and 2 (a depth of 0.2-0.5mm) are beforehand processed into the sintering mold, there is imprinted irregularity in the cast sintering electrode-holder base. It machined so that the flight width of the exact annular heights 1 might be anew set to 0.2mm, and the front face performed polish processing to 0.01mm of field granularity.

[0027] Film processing of the wafer maintenance side and vacuum suction groove surface of this base is carried out simultaneously. The chemical vacuum deposition of a high grade carbonization silicon was performed on \*\*\*\* bee, annular heights 1, and annular crevice 2 front face under two different vacuum evaporatio no conditions. One is the reduced pressure vacuum evaporatio no under the vacuum evaporatio no temperature of 1300 degrees C, an evaporation rate 10 - number 10 micrometer/h, and a non-oxidizing atmosphere, and others are the same vacuum evaporatio no temperature and the same evaporation rate, and are the ordinary-pressure vacuum evaporatio no under a non-oxidizing atmosphere. Diamond powder performed mechanical polishing for two obtained vacuum-chuck electrode-holder front faces for 5 hours. 500A of film front faces which 8A of film front faces deposited under the above-mentioned reduced pressure atmosphere was finished in rms by polish, and formed membranes under ordinary-pressure atmosphere was rms. When the X diffraction compared the crystal structure of both the vacuum evaporatio no film, the Miller-indices display (220) side of the crystal structure of the film which formed membranes under reduced pressure atmosphere was about 52 times as compared with the field of (111), and the thing under ordinary-pressure atmosphere was about 32 times. The above-mentioned example shows that the vacuum evaporatio no side with much [ ground processability ] orientation to a direction (220) is excellent. In \*\*\*\* and the crystal structure, with the material which carried out orientation, and the material of non-orientation, polish is proved difficult that it is a bird clapper, so that orientation is abolished.

[0028] Moreover, most pores cannot be found in a vacuum evaporatio no side, a \*\*\*\* bee, and a wafer adsorption side. Therefore, it is rare for a contaminant to adhere to an adsorption side, and when a contaminant intervenes between Wafers W, it cannot happen easily that the flatness of Wafer W falls. Moreover, since it is a high degree of hardness, by abb RESSHIBU wear, a particle does not occur and it does not necessarily adhere to Wafer W. Since alpha type carbonization silicon sintered compact is conductivity, adhesion of the contaminant to the vacuum-chuck electrode holder by generating of static electricity is not produced. Though a contaminant adheres, it can remove easily, and cleaning of a vacuum-chuck electrode holder is easy. Furthermore, since the coefficient of thermal expansion is small, the vacuum-chuck electrode holder of this example has few dimensional changes by \*\*\*\* at the time of

exposure. Therefore, when exposing with the light of low strength for a long time using the photoresist of high sensitivity, the size error of a wafer can be suppressed in tolerance.

[0029]

[Effect of the Invention] When a vacuum-chuck electrode holder comes to coat a conductive carbonization silicon sintered-compact top by the reduced pressure chemical-vacuum-deposition carbonization silicon film in the bottom of a non-oxidizing atmosphere in this invention and the generation film forms the crystal structure shows the effect which makes most difficult polish processing easy with ceramic material as mentioned above. Moreover, there is no pore in a crystallization film, and adhesion of the contaminant by generating of static electricity is prevented for conductivity, and cleaning of the supporting structure is also easy. Moreover, high rigidity peculiar to ceramics and the lightweight toughness of the vacuum-chuck electrode-holder structure which a property brings about are stabilized over a long time, and make it possible to perform flattening reform of the held object by wafer adsorption. Furthermore, since it has the property of high dimensional stability which a small coefficient of thermal expansion brings about, it is advantageous when the dimensional change by accumulation poses a problem.

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[Translation done.]

CLIPPEDIMAGE= JP409260471A

PAT-NO: JP409260471A

DOCUMENT-IDENTIFIER: JP 09260471 A

TITLE: SEMICONDUCTOR WAFER VACUUM CHUCK MADE OF SINTERED  
SILICON CARBIDE  
SUBSTRATE COATED WITH CHEMICALLY VAPORIZED SILICON CARBIDE

PUBN-DATE: October 3, 1997

INVENTOR-INFORMATION:

NAME

INOUE, KAZUO

ASSIGNEE-INFORMATION:

NAME

INOUE KAZUO

COUNTRY

N/A

APPL-NO: JP08090525

APPL-DATE: March 18, 1996

INT-CL (IPC): H01L021/68;C04B035/565 ;C04B041/87

ABSTRACT:

PROBLEM TO BE SOLVED: To provide good anti-abrasive characteristics and reduce contamination stuck to a vacuum chuck, by preventing static electricity at a contacted position with a workpiece.

SOLUTION: A position (of a vacuum chuck holder) contacted with a workpiece in a semiconductor wafer carrying and holding apparatus is made of ceramics composite, namely a silicon carbide substrate 6 that is coated with a film of the same kind of silicon carbide in a reduced pressure chemical evaporation method under non-oxidizing atmosphere. A composite material structure for the vacuum chuck holder includes a base substrate of  $\alpha$ -type or  $\beta$ -type

sintered silicon carbide, and the formed film is made of  
&beta;-type  
crystallized silicon carbide.

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**TECHNICAL FIELD**

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[The technical field to which invention belongs] this invention relates sheet metal-like substrates, such as for example, a semiconductor substrate (wafer), and an alumina, a quartz, to the vacuum chuck used suitable for adsorption fixation.

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PRIOR ART

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[Description of the Prior Art] In the manufacturing process of a semiconductor integrated circuit, the various supporting structure for conveying a wafer or fixing to a predetermined position is used. For example, in the aligner which bears the role rate of central of a lithography process, since a sheet metal-like wafer is fixed in a flat surface, the equipment of a vacuum chuck is used.

[0003] Conventionally, that by which the material used for this kind of vacuum-chuck main part performed alumite processing to the aluminium alloy, and alumina ceramics were used. In the vacuum-chuck electrode holder made from an aluminium alloy, there is a problem which cannot maintain precision of an adsorption side over a long period of time by wear etc. On the other hand, in the vacuum-chuck electrode holder made from alumina ceramics, at the time of use, a chuck electrode holder is charged, dust adheres and there is a problem to which the adsorption precision of a wafer falls.

[0004] moreover, detailed-izing of a semiconductor integrated circuit -- following -- a wafer exposure side -- a perfect two-dimensional flat surface -- and it is necessary overly to be a smooth side According to it, as for the profile irregularity of the adsorption side of the vacuum-chuck electrode holder which supports a wafer, a smooth side is overly needed. In field processing of the vacuum-chuck electrode holder formed with machining, although an ARUMYUUMU alloy is softly easy to process it, on the other hand, it deteriorates easily. Field polish of the vacuum-chuck electrode holder which consists of alumina ceramics is not firmly easy.

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EFFECT OF THE INVENTION

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[Effect of the Invention] When a vacuum-chuck electrode holder comes to coat a conductive carbonization silicon sintered-compact top by the reduced pressure chemical-vacuum-deposition carbonization silicon film in the bottom of a non-oxidizing atmosphere in this invention and the generation film forms the crystal structure shows the effect which makes most difficult polish processing easy with ceramic material as mentioned above. Moreover, there is no pore in a crystallization film, and adhesion of the contaminant by generating of static electricity is prevented for conductivity, and cleaning of the supporting structure is also easy. Moreover, high rigidity peculiar to ceramics and the lightweight toughness of the vacuum-chuck electrode-holder structure which a property brings about are stabilized over a long time, and make it possible to perform flattening reform of the held object by wafer adsorption. Furthermore, since it has the property of high dimensional stability which a small coefficient of thermal expansion brings about, it is advantageous when the dimensional change by accumulation poses a problem.

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 TECHNICAL PROBLEM
 

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- (2) Be, or pore should be charged and don't adsorb dust.
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- (5) Excel in workability.

It comes out. It is as follows when the above-mentioned property is seen in more detail.

[0006] The wafer and the vacuum-chuck electrode holder touch. A vacuum-chuck electrode holder loads and conveys a repeat wafer. Therefore, a front face is worn out and damaged. The state where a wafer is expected where a vacuum-chuck electrode holder is adsorbed is that the front face of a wafer is corrected by adsorption in the first place at the optimal position which the light of an aligner makes, a \*\*\*\* bee, and the most perfect possible 2-dimensional flat surface. Therefore, in order to prevent deformation of the wafer by the defect of the maintenance side resulting from wear of a electrode holder, and in order to prevent the wafer of a particle generated by abb RESSHIBU wear by contact to a wafer, and deformation of the flat surface by the intervention between electrode holders, it is desired for the abrasion resistance of the contact section of a vacuum-chuck electrode holder and a wafer and a degree of hardness to be high. Moreover, if a particle adheres to a front face, an open circuit and a short circuit will arise at the time of a circuit imprint.

[0007] The thing to the vacuum-chuck electrode holder with which the contaminant was charged besides the above-mentioned abb RESSHIBU wear to adsorb, the thing to ceramic surface pore to invade produce the aforementioned obstacle and the same obstacle.

[0008] Heat is accumulated by exposure in the vacuum-chuck electrode holder of an aligner. For this reason, when the coefficient of thermal expansion of a electrode holder is large, the dimensional change of the wafer by which adsorption fixation is carried out is made expanded to a electrode holder. Therefore, in order to suppress the size error at the time of a circuit imprint, it is desired for a coefficient of thermal expansion to be small as much as possible.

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[0010] The process which spends time and an effort most with machining of material is a polish process. It is necessary to carry out a deer and there overly needs to be a field where a vacuum-chuck electrode holder and a wafer contact in respect of smooth for the flatness reform by vacuum adsorption. It follows. The polish workability of vacuum-chuck electrode-holder material turns into an important property.

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MEANS

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[Means for Solving the Problem] By this invention, in order to solve the aforementioned technical problem, a vacuum-chuck electrode holder consists of ceramic complex which formed the of-the-same-kind carbonization silicon film by the reduced pressure chemical vacuum deposition under the non-oxidizing atmosphere on the sintering carbonization silicon base. In this invention, as desirable complex material composition used for a vacuum-chuck electrode holder, alpha type or beta type sintering carbonization silicon is used for a base, and the carbonization silicon of beta type structure which crystallized the formed film is mentioned.

[0013] Moreover, manufacture is easy in order to choose the membrane structure which does not use a carbonization silicon sintered compact for the contact section with a direct wafer in this invention, but uses a chemical-vacuum-deposition carbonization silicon film for a front face, and makes polish processing easy.

[0014] Moreover, the sintering carbonization silicon complex used for this invention has conductivity. High rigidity which a ceramic sintered compact has in a \*\*\*\* bee and the vacuum-chuck electrode holder of this invention. The property of conductivity is added to the property of lightweight and a high degree of hardness. Therefore, while abrasion resistance improves, generating of static electricity in a contact portion with a held object is prevented, and adhesion of a contaminant is reduced.

[0015] While the crystal face of a carbonization silicon front face prevents generating of damage as much as possible with fewer polish energy by improving originating in it being non-orientation, carrying out orientation of the crystal face of a carbonization silicon vacuum evaporation film, and arranging a cleavage plane in this invention, the surface polish of the difficulty of the surface polish in the conventional carbonization silicon material can overly be carried out in a smooth side.

[0016] Furthermore, the chemical-vacuum-deposition film in this invention is precise, and does not have pore like the usual ceramic front face. Therefore, in the contact section of the vacuum-chuck electrode holder of this invention, and a held object, there is no adhesion of the foreign matter to pore, and though adhered, cleaning removal is easy.

[0017] The physical properties of the chemical-vacuum-deposition carbonization silicon complex of each material currently used for the conventional vacuum-chuck electrode holder here and this invention are shown in Table 1. Each physical-properties value of stainless steel and an alumina which is a metal, ceramics, and each representation is shown as a comparison material.

[0018]

[Table 1]

	弾性率 (Kg/mm <sup>2</sup> )	比重	表面 気孔状態	電気抵抗 ( $\Omega \cdot \text{cm}$ )	硬度 (Hv)	熱膨張係数 ( $\times 10^{-6}/^{\circ}\text{C}$ )
ステンレス鋼	20,000	8.1	中	$7 \times 10^{-5}$	200	17.3
Al <sub>2</sub> O <sub>3</sub>	35,000	3.8	悪	$\geq 10^{14}$	1,800	7.1
焼結SiC + 蒸着SiC膜 (本発明)	40,000	3.1	良	$10^{10}$	2,500	4.1

[0019] As application evaluation weighted solidity to the electrode holder of which flatness is required, and the charge of transport-device material of which small and high performance are required, if the chemical-vacuum-deposition carbonization silicon complex of an elastic modulus according to this invention in both if an elastic modulus is compared with specific gravity is large and specific gravity is small, the value also with desirable \*\*\*\*\* is shown.

[0020] Moreover, a coefficient of thermal expansion is also the smallest in 3 persons, and even when accumulation is carried out by prolonged exposure, there are few dimensional changes. That is, the size error at the time of the wafer circuit imprint by which adsorption fixation is carried out can be low suppressed to a electrode holder.

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[Translation done.]

\* NOTICES \*

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OPERATION

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[Function] Offering a means by which the reduced pressure chemical-vacuum-deposition carbonization silicon complex under the non-oxidizing atmosphere of this invention solves many above-mentioned technical problems was shown. In this means, the processing difficulty of the ceramics generally said is solved upwards, and the vacuum evaporation film of this invention brings about an important operation and an effect.

[0022] In order to conquer the processing difficulty of ceramic material, electric spark forming is adopted. the slot where the field by which an electron discharge method is carried out adsorbs a wafer, and vacuum suction -- it is a hole and cannot but depend for the important field in contact with a wafer on polish processing The stage with the most difficult machining of ceramic material is polish processing.

[0023] The chemical-vacuum-deposition carbonization silicon film which becomes this invention generates various membrane structures according to vacuum evaporation conditions. And the effort of polish processing makes a greatly different operation by the membrane structure. For example, there is a vacuum evaporation film prepared and obtained so that the chemical vacuum deposition of the beta type carbonization silicon of a high grade may be carried out to the front face of the base which forms a vacuum-chuck electrode holder and orientation of the crystal face may be carried out to a Miller-indices display (220) side and a field (111). When this vacuum evaporation film was compared with the vacuum evaporation film of non-orientation in the polish energy in polish processing, and time, consumption energy had far few vacuum evaporation films which carried out orientation. And the clear difference was seen and the state of a polished surface was also excellent in the direction of an orientation film. The chemical-vacuum-deposition carbonization silicon complex ceramics for vacuum-chuck electrode holders which become a \*\*\*\* bee and this invention are carrying out the operation of the contact surface with the most important wafer which was overly excellent in processing of a smooth side, having a property equivalent to the ceramics currently used as present wafer maintenance material.

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[Translation done.]

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## EXAMPLE

[Example] Hereafter, the example of this invention is explained with reference to a drawing. The plan in which drawing 1 shows the rough structure of the vacuum-chuck electrode holder of this invention, and drawing 2 are the A.A' cross sections of drawing 1. Drawing 3 is some enlarged views of drawing 2. The slightly small path of the configuration of the wafer adsorption side of a electrode holder WH is more nearly circular than the diameter of Wafer W, and two or more concentric circle-like annular heights (wafer W supporter) 1 and annular crevices (vacuum adsorption slot) 2 are formed in the wafer adsorption side in the shape of a rim in the fixed pitch from the center of a electrode holder WH.

[0025] moreover, the inhalation of air for the vacuum adsorption in each annular crevice 2 -- a hole 3 arranges and forms in radial -- having -- each inhalation of air -- the hole 3 is open for free passage with the hole 4 of the shape of a sleeve extended to radial inside electrode-holder WH By tying this hole 4 to the source of a vacuum, and decompressing it, the space surrounded in the rear face and each annular crevice 2 of Wafer W becomes negative pressure, the rear face of Wafer W is learned from the upper surface of two or more annular heights 1, and flattening reform is carried out.

[0026] The carbonization silicon film which formed membranes by the non-oxidizing-atmosphere reduced pressure chemical vacuum deposition coated and constituted the electrode-holder WH main part from this example on the sintering carbonization silicon base. First, drawing 1 and alpha type carbonization silicon base which makes the configuration of drawing 2 were sintered. Since the annular irregularity sections 1 and 2 (a depth of 0.2-0.5mm) are beforehand processed into the sintering mold, there is imprinted irregularity in the cast sintering electrode-holder base. It machined so that the flight width of the exact annular heights 1 might be anew set to 0.2mm, and the front face performed polish processing to 0.01mm of field granularity.

[0027] Film processing of the wafer maintenance side and vacuum suction groove surface of this base is carried out simultaneously. The chemical vacuum deposition of a high grade carbonization silicon was performed on \*\*\*\* bee, annular heights 1, and annular crevice 2 front face under two different vacuum evaporatio no conditions. One is the reduced pressure vacuum evaporatio no under the vacuum evaporatio no temperature of 1300 degrees C, an evaporation rate 10 - number 10 micrometer/h, and a non-oxidizing atmosphere, and others are the same vacuum evaporatio no temperature and the same evaporation rate, and are the ordinary-pressure vacuum evaporatio no under a non-oxidizing atmosphere. Diamond powder performed mechanical polishing for two obtained vacuum-chuck electrode-holder front faces for 5 hours. 500A of film front faces which 8A of film front faces deposited under the above-mentioned reduced pressure atmosphere was finished in rms by polish, and formed membranes under ordinary-pressure atmosphere was rms. When the X diffraction compared the crystal structure of both the vacuum evaporatio no film, the Miller-indices display (220) side of the crystal structure of the film which formed membranes under reduced pressure atmosphere was about 52 times as compared with the field of (111), and the thing under ordinary-pressure atmosphere was about 32 times. The above-mentioned example shows that the vacuum evaporatio no side with much [ ground processability ] orientation to a direction (220) is excellent. In \*\*\*\* and the crystal structure, with the material which carried out orientation, and the material of non-orientation, polish is proved difficult that it is a bird

clapper, so that orientation is abolished.

[0028] Moreover, most pores cannot be found in a vacuum evaporation side, a \*\*\*\* bee, and a wafer adsorption side. Therefore, it is rare for a contaminant to adhere to an adsorption side, and when a contaminant intervenes between Wafers W, it cannot happen easily that the flatness of Wafer W falls. Moreover, since it is a high degree of hardness, by abb RESSHIBU wear, a particle does not occur and it does not necessarily adhere to Wafer W. Since alpha type carbonization silicon sintered compact is conductivity, adhesion of the contaminant to the vacuum-chuck electrode holder by generating of static electricity is not produced. Though a contaminant adheres, it can remove easily, and cleaning of a vacuum-chuck electrode holder is easy. Furthermore, since the coefficient of thermal expansion is small, the vacuum-chuck electrode holder of this example has few dimensional changes by \*\*\*\* at the time of exposure. Therefore, when exposing with the light of low strength for a long time using the photoresist of high sensitivity, the size error of a wafer can be suppressed in tolerance.

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[Translation done.]